Appendix 1

Technical Appendix: Table of Contents

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Overview

This technical appendix is intended for health services researchers, healthcare providers, and others interested in the methods used to calculate risk-adjusted mortality rates.

The risk-adjustment model used to derive hospital-specific results for community-acquired pneumonia (CAP) was developed through a multi-step process, explained in detail in the "*Report for the California Hospital Outcomes Program, Community-Acquired Pneumonia, 1996: Model Development and Validation*." The development of the model involved reviewing the scientific literature, convening an expert panel, developing criteria for including and excluding cases, identifying adverse outcomes, selecting risk factors, estimating the statistical model, refining and testing the model, and calculating risk-adjusted outcome measures for CAP admissions reported during 1996. For this report, coefficients for risk factors included in that model were re-estimated using discharge data from 1999 to 2001.

Selection Criteria

This report focuses on patients admitted for CAP at acute care hospitals in California. Inclusion and exclusion criteria were developed after careful review of the medical literature and extensive discussions with an expert panel that included a pulmonologist, a nurse researcher, a pulmonary care nurse, a pharmacist, and a health information management professional.

Inclusion Criteria

CAP patients were selected by reviewing the discharge abstracts from all acute care hospitals in California that report data to the Office of Statewide Health Planning and Development (OSHPD). These hospitals do not include facilities operated by the U.S. Department of Veterans Affairs or the Department of Defense. Discharge abstracts that identified patients admitted from a non-acute level of care (e.g., skilled nursing, rehabilitation) were excluded.

For patients with two or more CAP admissions during the three-year period of this report, only the first admission was considered. In other words, the unit of analysis for this report is unduplicated patients. This definition fulfills the general requirement of case independence for the statistical analysis model used in this report. Throughout this report, the first admission will be referred to as the "index admission."

Cases selected for this report were required to meet all four of the inclusion criteria listed below.

1. **A principal diagnosis of community-acquired pneumonia or a specified pneumonia-related principal diagnosis with a secondary diagnosis of community-acquired pneumonia.**

The principal diagnosis is "the condition established, after study, to be chiefly responsible for occasioning the admission of the patient to the hospital for care." Secondary diagnosis is defined as "conditions that coexist at the time of admission, develop subsequently during the hospital stay, affect the treatment received, or affect the length of stay."[2] Table A.1 shows both the principal diagnosis of CAP, and the non-CAP principal diagnosis codes. If CAP was the principal diagnosis, the patient was selected. For patients with CAP-related principal diagnoses (e.g., cough), a secondary diagnosis of CAP was required for selection. This approach was

[2] Office of Statewide Health Planning and Development, March 2001. 1999 Patient Discharge Data File Documentation.

used in prior research on community-acquired pneumonia.[3] Table A.1 and Table A.2, taken together, represent those ICD-9-CM (International Classification of Diseases - 9th Revision - Clinical Modification) diagnoses typically considered to represent community-acquired pneumonia.[4]

2. Age at admission of 18 years or greater.

This study included adults only. The clinical spectrum of pneumonia for children is significantly different, and would therefore necessitate developing more than one risk-adjustment system and validation instrument. This report excluded 72,007 patients because they were younger than 18 at the time of admission.

3. Source of admission is "Home."

Because this study is focused on community-acquired pneumonia, only patients whose source of admission was "Home" were included in the report. Patients admitted from "Residential Care Facilities" and "Prison/Jail" were not included since patients who have been institutionalized may be exposed to organisms with different patterns of antibiotic resistance than individuals who live in non-institutional settings.

Patients admitted from "Long-Term Care" and "Other Inpatient Hospital Care" were not included because they are exposed to bacteria that do not typically exist in the community (i.e., they are exposed to bacteria that cause "hospital-acquired pneumonia"). Bacteria that cause hospital-acquired pneumonia have a different, often more severe, clinical course than bacteria that are typically associated with CAP. Patients transferred from a long-term care facility are also more likely to have a higher incidence of "Do Not Resuscitate" (DNR) orders. Patients with DNR orders have a higher risk of underlying medical conditions that may not be fully measured in a risk-adjustment system using administrative data. In addition, certain life-prolonging measures may not be used for patients with DNR orders, possibly introducing bias into the risk-adjustment process. "Ambulatory Surgery" and "Other" patients were also not included, as it was not known where these patients normally resided. This study excluded 55,367 patients because their source of admission to the hospital was not "home."

4. Date of discharge between January 1, 1999 and December 31, 2001, and date of admission not earlier than November 1, 1998, and date of admission not later than December 1, 2001.

Patients admitted before November 1, 1998 were excluded because the study was designed to capture CAP patients primarily treated between 1999 and 2001. Patients admitted after December 1, 2001 and before January 1, 2002 (N=8,449) were excluded because vital statistics data were not available after December 31, 2001 and their 30-day mortality could not be completely determined.

Exclusion Criteria

Several exclusion criteria, such as a recent history of pneumonia that was acquired in the hospital, were defined to eliminate patients that may not truly represent CAP. Cases with any of the following characteristics were excluded.

[3] Iezzoni LI, Shwartz M, Ash A, Mackieman YD. Using severity measures to predict the likelihood of death for pneumonia inpatients. J Gen Intern Med. 1996; 11:23-31.

[4] Fine M, Singer DE, Hanusa B, et al. Validation of a Pneumonia Prognostic Index Using the MedisGroups Comparative Hospital Database. The American Journal of Medicine. 1993; 94:153-159.

1. One or more prior acute inpatient hospital admissions within 10 days preceding the index CAP admission (N=11,702 patients excluded).

A CAP admission was excluded from the study if it was preceded by a prior acute hospital admission for any reason within 10 days (from prior discharge date to index date). This exclusion is important because recent hospitalizations put a patient at risk for hospital-acquired pneumonia. Bacteria associated with hospital-acquired pneumonia may have greater resistance to antibiotics, and therefore may be more difficult to treat than bacteria associated with CAP.

2. Any diagnosis code on the index hospital record indicating trauma.

These patients were excluded because it was highly likely that an accident victim would have acquired pneumonia in the hospital (N=7,623 patients excluded).

3. Discharges with diagnosis codes indicating that a patient had undergone organ transplant, had human immunodeficiency virus (HIV) or AIDS, had cystic fibrosis, tuberculosis, post-operative pneumonia, or certain unusual pathogens as the cause of the pneumonia.

In addition to typical bacterial pathogens that cause CAP, individuals with AIDS or HIV infection are subject to a variety of HIV-related pathogens that are distinct from those underlying CAP. Therefore, 2,195 records indicating an HIV-related diagnosis were excluded. Similarly, since patients who have undergone an organ transplant receive medications to suppress their immune system, they are susceptible to bacteria and other organisms that do not cause CAP (522 discharges excluded). Patients with cystic fibrosis are not able to clear bacteria effectively from their lungs and are susceptible to frequent pneumonia. The frequency of pneumonia and the associated courses of antibiotics make them susceptible to antibiotic-resistant bacteria, thereby posing problems with treatment (770 discharges excluded). Patients with tuberculosis were excluded because this type of pneumonia requires specific antibiotics and has a very different clinical course than patients with CAP (455 discharges excluded). Patients with postoperative pneumonia are clinically classified as having hospital-acquired pneumonia (1,308 discharges excluded). Some unusual pneumonias (e.g., anthrax) were also excluded because these organisms are treated with specific antibiotics and have a different clinical course (1,423 discharges excluded). Table A.2 lists the pneumonia diagnoses that were excluded because their etiologies and treatment regimes are clinically distinct from most community-acquired pneumonias.

4. Other exclusions.

Because a social security number is required for linking index records with prior hospitalization records and with the State's vital statistics records 7,824 patients with missing or invalid social security numbers were excluded.. An additional 636 patients were excluded because they had unresolved social security numbers attributed to different individuals having grossly inconsistent birth dates or genders. Ten patients whose sex was not identified as either male or female were also excluded. In addition, 129 patients with a date of admission that occurred after the date of death were excluded, as well as 7 patients with date of death missing. 4,478 patients with out-of-state ZIP codes were excluded because reliable information about out-of-state vital statistics was not available.

Table A.1: CAP Diagnoses Included in the Analysis

ICD-9-CM Code	Principal Diagnosis	Principal CAP Codes	Non-CAP Principal Diagnosis Codes*
480.0	Pneumonia due to adenovirus	X	
480.1	Pneumonia due to respiratory syncytial virus	X	
480.2	Pneumonia due to parainfluenza virus	X	
480.8	Pneumonia due to other virus not elsewhere classified	X	
480.9	Viral pneumonia, unspecified	X	
481	Pneumococcal Pneumonia (*Streptococcus pneumoniae*)	X	
482.0	Pneumonia due to *klebsiella* pneumoniae	X	
482.1	Pneumonia due to *pseudomonas*	X	
482.2	Pneumonia due to *hemophilus influenza*	X	
482.30	Pneumonia due to *streptococcus,* unspecified	X	
482.31	Pneumonia due to *streptococcus*, Group A	X	
482.32	Pneumonia due to *streptococcus*, Group B	X	
482.39	Other s*treptococcus* species	X	
482.4	Pneumonia due to s*taphylococcus* species	X	
482.81	Pneumonia due to other specified bacteria - Anaerobes	X	
482.82	Pneumonia due to *escherichia coli* (E. Coli)	X	
482.83	Other gram negative bacteria	X	
482.84	Legionnaires' disease	X	
482.89	Other specified disease	X	
482.9	Bacterial pneumonia unspecified	X	
483.0	Pneumonia due to other specified organism-*mycoplasma*	X	
483.1	Pneumonia due to other specified organism - *chlamydia*	X	
483.8	Pneumonia due to other specified organism	X	
485	Bronchopneumonia, organism unspecified	X	
486	Pneumonia, organism unspecified	X	
487.0	Influenza with pneumonia	X	
510.0	Empyema with fistula		X
510.9	Empyema without fistula		X
511.0	Pleurisy without mention of effusion or current tuberculosis		X
511.1	Pleurisy with effusion, with bacterial cause other than tuberculosis		X
512.0	Spontaneous tension pneumothorax		X
512.1	Iatrogenic pneumothorax		X
512.8	Other spontaneous pneumothorax		X
513.0	Abscess of lung		X
518.0	Pulmonary Collapse		X
518.81	Respiratory failure		X
518.82	Other pulmonary insufficiency, not elsewhere classified		X
785.5x	Shock without mention of trauma - shock unspecified		X
786.00	Dyspnea and respiratory abnormalities-respiratory abnormality, unspecified		X
786.09	Other dyspnea and respiratory abnormalities		X
786.2	Cough		X
786.3	Hemoptysis		X
786.4	Abnormal sputum		X
038.xx	Septicemia		X

* To be used as an inclusion criterion, a non-CAP principal diagnosis must occur with a secondary diagnosis of CAP.

Table A.2: Pneumonia Diagnoses Excluded from Analysis

ICD-9-CM Code	ICD-9-CM Description
Fungal Pneumonia	
112.4	Candida species
114.0	Primary Coccidioimycosis
115.05, 115.15, 115.95	Histoplasmosis Pneumonia
484.6	Aspergillosis Pneumonia
484.7	Pneumonia from Other Systemic Mycoses
Other Miscellaneous Pneumonias	
136.3	Pneumocystis Carinii
484.1	Pneumonia from Cytomegalovirus
484.3	Pneumonia from Whooping Cough
484.5	Pneumonia from Anthrax
484.8	Pneumonia in other Infectious Disease
73.0	Ornithosis with Pneumonia
39.1	Primary Actinomycosis
55.1	Post-Measles Pneumonia
003.22	Salmonella Pneumonia
130.4	Pneumonia Due to Toxoplasmosis
21.2	Pulmonary Tularemia
52.1	Varicella Pneumonitis

*To be used as an inclusion criterion, a non-CAP principal diagnosis must occur with a secondary diagnosis of CAP.

Linking Index Records with Prior Hospitalization Records and Death Records

Record linkages are important for several reasons. First, linking the "index admissions" selected for this report with subsequent hospital discharge abstracts and death certificates provides the basis for measuring death within 30 days. Second, linkage with prior hospitalizations makes it possible to identify possible hospital-acquired pneumonia. Third, linkages provide important information about clinical risk factors. Asthma, liver disease, and other comorbidities are not always coded on discharge abstracts submitted by the index hospital so more complete information can be obtained when linked, multiple admission records are used.

The Record Linkage Process

The goal of the record linkage process was to identify records from different data files for the same individual, and to create a linked single-record analysis file. This was accomplished through the following three general steps:

Step 1. Index admissions were identified that met the selection criteria described above.

Step 2. Index admission records were linked to vital statistics death records. Each death record was linked to all applicable records in the patient discharge data files, but each patient discharge data record was linked to only one possible death. The linkage was performed deterministically, following specific criteria and rules that used social security number as the primary linkage key. A detailed description of the algorithm used to link index CAP records with vital statistics records can be found in the Technical Guide of OSHPD's report on heart attacks for 1996-1998. (This Technical Guide can be viewed at www.oshpd.ca.gov)

For all CAP discharge records meeting the inclusion criteria of this report, approximately 3.7 percent were missing a social security number. Table A.3 shows which hospitals lacked social security numbers for 10 percent or more of their patient discharge records. Records lacking a social security number could not be used because they could not be linked to vital statistics

records using the linkage algorithm of this report. No hospitals were excluded from the report because of missing social security numbers. No effort was made to assess whether missing social security numbers were correlated with the presence or absence of observed 30-day mortality,

Step 3. Additional discharge records for each patient, for up to six months prior to the index admission, were located and linked with the appropriate index records. Again, social security number was used as the primary linkage key.

Table A3: Hospitals with 10 Percent or More of their CAP Patients Missing Social Security Number, 1999-2001

Hospital Name[5]	Number of Patients	Percent Missing SSN
Children's Hospital of Orange County	10	40.0
Los Angeles County USC Medical Center	1,636	39.1
Los Angeles County Olive View Medical Center	797	32.2
Los Angeles County Rancho Los Amigos Medical Center	13	30.8
Los Angeles County ML King Jr./ Drew Medical Center	1,157	29.2
Los Angeles County Harbor/ UCLA Medical Center	1,003	27.9
George L. Mee Memorial Hospital	124	25.0
Alameda Hospital	327	23.5
San Mateo General Hospital	233	20.2
Sierra View District Hospital	726	20.2
Los Angeles County High Dessert Hospital	59	16.9
Santa Clara Valley Medical Center	752	15.6
Los Angeles Community Hospital- Norwalk	162	14.2
San Bernardino County Medical Center	76	13.2
Madera Community Hospital	458	12.9
Arrowhead Regional Medical Center	795	12.5
Riverside County Regional Medical Center	591	12.5
University of California Irvine Medical Center	544	12.3
California Hospital Medical Center	499	12.2
Coastal Communities Hospital	270	12.2
University Medical Center	708	12.1
Kaiser Foundation Hospital Richmond	321	12.1
Valley Children's Hospital	25	12.0
Natividad Medical Center-Constitution Blvd.	242	12.0
Los Angeles Community Hospital	194	11.9
Doctors Hospital of West Covina	17	11.8
Western Medical Center-Anaheim	214	11.7
Ventura County Medical Center	294	11.6
Lindsay District Hospital	56	10.7
Greater El Monte Community Hospital	265	10.6
Hospitals Statewide	210,852[6]	3.7

[5] One hospital with 1 CAP admission and 100% missing SSN and one hospital with 6 CAP admissions and 33.3% missing SSN were not included in this table because of their small Ns.

[6] This figure is larger than the 203,028 patients used to create the rankings in this report because it includes patients with missing social security numbers.

Measurement of 30-Day Mortality

Only one outcome of hospitalization for community-acquired pneumonia was studied: death within 30 days of admission. Although other measures such as "improved health" or "improved ability to do everyday tasks" are desirable, mortality was chosen because it is important, definitive, and readily available. Thirty-day death rates are used instead of in-hospital death rates because the former measure is insensitive to transfer policies that could bias results and are a more robust outcome. In selecting this outcome measure, statistical and clinical issues were considered. For example, death is a frequent outcome of CAP hospitalizations: One person in eight admitted to a California hospital for CAP between 1999 and 2001 died within 30 days. Also, death resulting from CAP may be prevented by appropriate therapy such as the timely administration of antibiotics.[7] Furthermore, a medical intervention associated with the performance of sputum cultures can reduce the risk of early death after admission to a hospital for CAP.[8]

Identification of Death

Deaths within 30 days of admission were determined using two different data sources: linked hospital discharge abstracts and vital statistics records (death certificates). Hospital discharge abstracts only record deaths that occur in nonfederal acute care hospitals in California. By contrast, a death certificate is generated whenever a California resident dies, regardless of where the death occurs. Patient discharge records were matched with vital statistics records using social security number as the primary linkage key. This allowed for the calculation of 30-day death rates, instead of being limited to inpatient death rates.

To investigate the probability that the linkage with the State's vital statistics file accurately identified all known deaths, the linkage's sensitivity to known inpatient deaths was measured by determining how many of the inpatient CAP deaths recorded by hospitals on the patient discharge abstract were also present in the vital statistics file. Of the 15,681 inpatient deaths that occurred during a CAP admission between January 1, 1999 and December 1, 2001, 15,489 were also recorded in the vital statistics file. This yielded an error rate of 0.01, meaning that nearly all of the CAP patients who died while in the hospital were also accurately represented in the vital statistics file. The small number of inpatient deaths (N=192) not found in California's vital statistics file could represent patients who were out-of-state residents at the time of their death, or patients whose hospital discharge abstracts contained erroneous social security numbers that could not be validly linked.

For the 203,028 CAP patients meeting our selection criterion, 15,148 deaths were reported through the patient discharge files as "in-hospital" within 30 days of admission.[9] Of the 187,347 CAP patients discharged alive from the hospital, an additional 9,681 were identified as having died within 30 days of admission (for a total of 24,829 deaths within 30 days of admission). This means that 39 percent of the deaths measured by this report occurred outside of a hospital.

All 24,829 30-day deaths identified from these data sources were used to measure the outcome of this report. Deaths beyond 30 days were not counted because these later deaths may have resulted from social problems or unrelated illnesses. Not counting later deaths made the outcome comparisons across hospitals more valid. Other cutoffs were considered but the 30-day limit was adopted because it is consistent with previous research in the field.

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[7] Meehan TP, Fine MJ, Krumholz HM, et al., "Quality of Care, Process, and Outcomes in Elderly Patients with Pneumonia." *JAMA*. 1997; 278(23): 2080-4.

[8] Haas J, et. Al., "Report for the California Hospital Outcomes Project: Community-Acquired Pneumonia, 1996," Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page "12-9."

[9] This inpatient death figure is lower than 15,681 because 533 inpatient deaths occurred later than 30 days after being admitted for CAP.

Selection of Hospitals

Certain hospitals may not be directly comparable with the majority of hospitals caring for CAP patients in California. For example, non-acute care hospitals are not organized and staffed to treat patients with acute conditions. Any CAP records from these hospitals are probably either miscoded or represent atypical patients.

This report includes cases from all non-federal acute care hospitals in California. Hospitals operated by the U.S. Department of Veterans Affairs or Department of Defense do not report data to OSHPD and therefore could not be included. All acute care hospitals reporting discharge information to OSHPD for patients with CAP were initially eligible for inclusion.[10] Although some hospitals with distinct psychiatric or alcohol and drug rehabilitation patients can report in this category, they should not have patients with principal diagnoses of CAP, or that are CAP-related. Thus, patients with the following reported levels of care were excluded: "Psychiatric," "Alcohol/Drug Rehabilitation," "Skilled Nursing/Intermediate Care," and "Rehabilitation."

If a general acute care hospital consolidated with another general acute care hospital between 1999 and 2001 and then stopped reporting to OSHPD using its original hospital identification number, all discharges reported after the consolidation were attributed to the hospital named in the consolidation. Discharges prior to the consolidation retained their original identification number. If a hospital changed location and then started reporting to OSHPD using a different identification number, it was reported separately using the same hospital name with a different street address.

Twenty-nine hospitals included in this report did not have qualifying admissions for community-acquired pneumonia during one or two of the three years of this report. This could have occurred because a hospital closed or opened later during the three-year interval of this report. The hospitals that were not represented by a full three-year period are listed in Table A.4. Due to small numbers, some of these hospitals were not rated (See Table A.17).

Definitions and Prevalence of Risk Factors

In this study, risk factors were defined as characteristics or conditions that most likely existed at the time of admission and may have influenced patient outcomes. Four types of risk factors were examined:

- demographic characteristics such as gender and age
- hospitalization characteristics such as number of prior admissions
- chronic clinical risk factors such as asthma, liver disease, and lung cancer
- acute clinical risk factors that may or may not be present at admission to a hospital such as respiratory failure, coagulation deficit, and acute cerebrovascular accident

All clinical risk factors --chronic and acute-- were based on the diagnoses and procedures listed on discharge abstracts and coded using the International Classification of Diseases-9th Revision-Clinical Modification (ICD-9-CM). Each patient discharge abstract includes a principal diagnosis and principal procedure, plus as many as 24 other diagnoses and as many as 20 other procedures.

[10] This involved selecting all CAP records with a "level of care" code indicating "General Acute Care."

Table A.4: Number of Annual Admissions per Year for Hospitals with No CAP Admissions in at Least One Year of this Report

County	Hospital	1999	2000	2001
Alameda	Children's Hospital Med Ctr of No Cal	0	4	0
Amador	Sutter Amador Hospital-Court St	111	34	0
Amador	Sutter Amador Hospital-Mission Blvd	0	33	83
Contra Costa	Doctors Med Ctr-Pinole	89	27	0
Los Angeles	Bay Harbor Hospital	139	2	0
Los Angeles	Earl & Loraine Miller Children's Hosp	0	1	3
Los Angeles	Temple Community Hospital	57	0	99
Madera	Chowchilla District Memorial Hosp	3	0	0
Marin	Novato Community Hospital-Rowland	0	0	26
Monterey	Natividad Med Center-Natividad Rd	51	0	0
Orange	Martin Luther Hospital Med Ctr	104	0	0
Orange	Orange Coast Memorial Med Ctr	170	0	238
Orange	Vencor Hospital-Brea	0	1	0
Riverside	The Heart Hospital, Inc.	3	0	0
Sacramento	Mercy American River Hospital	253	103	0
San Bernardino	Heritage Hospital	1	0	0
San Bernardino	Mountains Community Hospital	37	16	0
San Bernardino	San Bernardino County Med Ctr	66	0	0
San Bernardino	Vencor Hospital-Ontario	1	0	0
San Diego	Columbia Mission Bay Hospital	96	82	0
San Diego	Scripps Hospital-East County	218	106	0
San Diego	Sharp Cabrillo Hospital	9	0	0
San Diego	Vencor Hospital-San Diego	3	0	0
San Francisco	UCSF-Mt Zion	177	0	0
San Mateo	Seton Med Ctr-Coastside	1	0	0
Santa Clara	Columbia South Valley Hospital	110	0	0
Santa Clara	Lucile S Packard Children Hosp at Stanford	0	0	2
Santa Clara	St. Louise Health Center	51	0	0
Tulare	Alta Hospital District	76	44	0
Tulare	Lindsay District Hospital	37	13	0

Demographic and Hospitalization Characteristics

The demographic fields available from patient discharge abstracts are gender, race/ethnicity, and age. Table A.5 describes these fields based on the records of the CAP patients selected for this report. For analytic purposes, race/ethnicity was aggregated into six categories: “Caucasian,” “African-American,” “Hispanic,” “Native American,” “Asian/Pacific Islander,” and “Other.” The validation study assessed the possible contributions of all demographic characteristics, but found only age and gender to be sufficiently predictive for use in the risk-adjustment model.

Several fields describing the hospitalization event were available from patient discharge abstracts: expected principal source of payment, source of admission, type of admission, number of prior discharges within the previous six months, and disposition. Each of these is described in Table A.6. Only number of prior discharges within the previous six months was selected by the validation study for use in the risk-adjustment model.

Table A.5: Demographic Characteristics of Community-Acquired Pneumonia Cases (after exclusions)

Characteristic	1999 Number	1999 Percent	2000 Number	2000 Percent	2001 (Jan.-Nov.) Number	2001 (Jan.-Nov.) Percent
Total Patients	78,541		64,957		59,530	
Gender						
Male	37,195	47.4	30,705	47.3	27,963	47.0
Female	41,346	52.6	34,252	52.7	31,567	53.0
Race/Ethnicity						
Caucasian	53,802	68.5	44,728	68.9	40,334	67.8
African-American	6,552	8.3	5,280	8.1	4,806	8.1
Hispanic	10,831	13.8	9,135	14.1	8,766	14.7
Native American	217	0.3	127	0.2	134	0.2
Asian/Pacific Islander	5,555	7.1	4,247	6.5	4,212	7.1
Other	1,049	1.3	980	1.5	930	1.6
Missing/Unknown	535	0.7	460	0.7	348	0.6
Age						
Mean	69.6		69.5		69.2	
Standard Deviation	17.0		17.2		17.3	

Table A.6: Hospitalization Characteristics of Community-Acquired Pneumonia Patients (after exclusions)

Characteristic	1999 Number	1999 Percent	2000 Number	2000 Percent	2001 (Jan.-Nov.) Number	2001 (Jan.-Nov.) Percent
Total Patients	78,541		64,957		59,530	
Admission Type						
Scheduled	2,144	2.5	1,607	2.5	1,462	2.5
Unscheduled	76,269	97.5	63,238	97.4	58,049	97.5
Missing/Unknown	128	0.2	112	0.2	19	0.0
Payment Source						
Missing	125	0.2	27	0.0	1	0.0
Medicare	50,332	64.1	42,169	64.9	37,990	63.8
Medi-Cal	8,092	10.3	6,646	10.2	6,369	10.7
Private Coverage	15,597	19.9	12,630	19.4	11,861	19.9
Worker Compensation	80	0.1	60	0.1	50	0.1
County Indigent Programs	1,470	1.9	1,220	1.9	1,055	1.8
Other Govt.	395	0.5	284	0.4	248	0.4
Other Indigent	213	0.3	172	0.3	170	0.3
Self Pay	1,743	2.2	1,383	2.1	1,367	2.3
Other Payer	494	0.6	366	0.6	419	0.7
Number of Prior Discharges						
Mean	0.5		0.5		0.5	
Standard Deviation	1.1		1.0		1.0	

Criteria for Selecting Clinical Risk Factors

The 1996 CAP development and validation study relied on a review of the recent medical literature and the assistance of a clinical advisory panel, to identify potential clinical risk factors for death after being admitted for CAP. A listing of Clinical Advisory Panel members may be found in the report. Drawing upon the clinical literature, the development and validation study documented the major risk factors associated with 30-day mortality for adults admitted because of CAP. This literature summary was used, in consultation with a clinical advisory panel, to identify potential risk factors to be used in model development. However, only those risk factors reported to OSHPD's patient discharge abstract could be used. The resulting set of clinical risk factors (found in the literature review and in OSHPD's discharge data set) was supplemented with additional risk factors from the patient discharge abstract that exhibited prevalences greater than 1 percent and statistically significant bivariate correlations with 30-day mortality.

Only risk factors found by the validation study to be reliably coded were included in the model. Some risk factors that were significantly correlated with 30-day mortality were excluded from the model due to unreliable coding. Other risk factors that were both reliably coded and significantly correlated with 30-day mortality were not included in the final model because they did not enter into a substantial number of the bootstrap sample-based analyses conducted by the validation study. Risk factors not significantly associated with 30-day mortality in a preliminary multivariate risk-adjustment model, as well as those that the clinical panel reviewed and found to lack clinical justification because of counter-intuitive associations with mortality, were also eliminated. Low frequency, physiologically related risk factors (those present in less than 1 percent of all cases) were —whenever possible— combined with physiologically related risk factors that showed a similar association with mortality.

Clinical Risk Factors

Table A.7 shows the ICD-9-CM codes for clinical risk factors included in the CAP risk-adjustment model. Table A.8 shows the codes for clinical risk factors considered but not included in the model. Table A.9 shows the prevalences of the clinical risk factors included in the model.

The final model created by the development and validation study included a single interaction effect (designated "Age*Liver interaction") between "age" and "chronic liver failure." While this interaction effect was found to be statistically significant, its parameter estimate of 0.003 was relatively low, and its odds ratio of 1.00 indicated that it did not contribute to the model. For the three years of discharge data used in the present report, this interaction effect showed a similar parameter coefficient and odds ratio. After consulting with the risk-adjustment model's developer this interaction was dropped from the final model used in this report.

The risk-adjustment model developed by the validation study did not include DNR status as a risk factor because it was not available on the Patient Discharge Data (PDD) in 1996. DNR status was included as a risk factor in this report because it became available on the PDD in 1999, because it may indicate severe illness, and because it predicts 30-day mortality.

Apart from the addition of DNR status as a risk factor, and the removal of the "Age*Liver Disease" interaction, this report employs the same risk factors included in the development and validation study's risk-adjustment model for 1996 discharges. The risk-adjustment model developed using 1996 data was carefully reviewed with members of the CAP clinical advisory panel and outside consultants. The advisory panel included a pulmonologist, a nurse researcher, a pharmacist, and a coding professional with specialized expertise in the topic. They advised the model development staff about whether the models included appropriate covariates and whether the parameter estimates were consistent with previous research and experience in the field. The advisory panel was not reconvened for this CAP report. The model parameter estimates used in this report were re-estimated to reflect the 1999-2001 discharge data.

Table A.7: ICD-9-CM Codes for Clinical Risk Factors Included in the CAP Risk-Adjustment Model

ICD-9-CM Code	ICD-9-CM Description	Source of Data*	Eligible Positions for Index Admission
	Respiratory Failure	Index Only	Principal or Secondary
518.81	Respiratory failure		
518.82	Other pulmonary insufficiency NEC		
	Solid Non-Lung Cancer	Index or Prior	Secondary
140.x - 160.x	Malignant neoplasm of head, neck, digestive organs and peritoneum		
170.x-172.x	Malignant neoplasm of bone, connective tissue, malignant melanoma of skin		
174.x	Malignant neoplasm of female breast		
179.x-189.x	Malignant neoplasm of genitourinary organs		
191.x-192.x	Malignant neoplasm of brain and other CNS		
193.x-195.x	Malignant neoplasm of thyroid, endocrine glands		
196.x-199.x	Secondary malignant neoplasm		
V10.0x	Personal history of malignant neoplasm		
	Septicemia	Index Only	Principal Only
038.xx	Septicemia		(CPAA coding not accurate enough to justify inclusion if coded in Secondary position)
790.7	Bacteremia		
	Lung Cancer	Index or Prior	Secondary
162.x	Malignant neoplasm of trachea, bronchus, and lung		
163.x	Malignant neoplasm of pleura		
165.x	Malignant neoplasm of other respiratory site		
	Chronic Liver Disease	Index or Prior	Secondary
571.x	Chronic liver disease and cirrhosis		
572.x-573.x	Liver abscess and sequelae of chronic liver disease, other disorders of the liver		
070.22, 070.32, 070.44, 070.54	Chronic hepatitis		
	Blood Cancer	Index or Prior	Secondary
200.x-203.x	Lymphosarcoma and reticulosarcoma, Hodgkin's disease, other malignant neoplasms of lymphoid and histiocytic tissue, multiple myeloma and histiocytic tissue, multiple myeloma and immunoproliferative neoplasms		
204.XX-208.XX	Leukemia		
284.x, 273.8	Aplastic anemia, other disorders of plasma protein metabolism		
	Chronic Renal Disease	Index or Prior	Secondary
585	Chronic renal failure		
403.91	Unspecified hypertensive renal disease with renal failure		
403.01, 403.11	Malignant, benign hypertensive renal disease with renal failure		
404.02, 404.12, 404.92	Malignant, benign, unspecified hypertensive heart and renal disease with renal failure		
996.73	Other complications of internal prosthetic device, implant, and graft due to renal dialysis device		

Table A.7: ICD-9-CM Codes for Clinical Risk Factors Included in the CAP Risk-Adjustment Model (continued)

ICD-9-CM Code	ICD-9-CM Description	Source of Data*	Eligible Positions for Index Admission
V45.1	Renal dialysis status		
	Coagulopathy	Index Only	Secondary
287.4, 287.5, 287.9	Secondary thrombocytopenia, unspecified thrombocytopenia, unspecified hemorrhagic conditions		
286.6, 286.7, 286.9	Defibrination syndrome, acquired coagulation factor deficiency, other and unspecified coagulation defects		
	Staphylococcus Pneumonia	Index Only	Principal or Secondary
482.4	Pneumonia due to Staphylococcus species		
	Congestive Heart Failure (CHF)	Index or Prior	Secondary
398.91	Rheumatic heart failure (congestive)		
402.91	Unspecified hypertensive heart disease with CHF		
404.01, 404.11, 404.91	Malignant, benign, and unspecified hypertensive heart and renal disease with CHF		
404.03, 404.13, 404.93	Malignant, benign, and unspecified heart and renal disease with CHF and renal failure		
425.x	Cardiomyopathy		
428.x	Heart Failure		
	Gram Negative Pneumonia	Index Only	Principal or Secondary
482.0, 482.1, 482.82	Pneumonia due to Klebsiella pneumonia, pneumonia due to Pseudomonas, pneumonia due to Escherichia coli		
	Late Effects of Stroke/Hemiplegia	Index or Prior	Secondary
342xx 438.xx	Hemiplegia and hemiparesis		
	Asthma	Index or Prior	Secondary
493.xx	Asthma		
	Acute Cerebrovascular Accident	Index or Prior	Secondary
430;431;432.x-435.x; 437.1	Subarachnoid hemorrhage; intracerebral hemorrhage; other and unspecified intracranial hemorrhage, occlusion and stenosis of precerebral arteries, occlusion of cerebral arteries, transient cerebral ischemia; acute but ill-defined cerebrovascular disease; other generalized ischemic cerebrovascular disease		
	Parkinson's Disease	Index or Prior	Secondary
332.x	Paralysis agitans, secondary parkinsonism		

* Index hospitalization only or also includes data from prior hospitalizations (if any).

Table A.8: ICD-9-CM Codes for Risk Factors Considered, but not Included in Final Model

ICD-9-CM Code	ICD-9-CM Description
	Acidosis
276.2	Acidosis
	Acute Renal Failure
584.x	Acute renal failure
	Airway Obstruction, Chronic
491.x; 492.x; 496	Emphysema; chronic airway obstruction not elsewhere classified
	Alcohol Use
291.x, 357.5x, 303.x, 305.0x, 571.2x, 571.1x, 571.3x, 571.0x, 425.5x, V11.3	Assorted complications of alcohol abuse
	Anemia
280.x, 281.x, 282.x, 283.x, 285.x	Assorted causes of anemia
	Aspiration Pneumonia
507.x	Pneumonitis due to inhalation of food or vomitus, due to inhalation of oils and essences, due to other solids and liquids
	Anoxic Brain Damage
348.1	Anoxic brain damage
	Atrial Fibrillation
427.3x	Atrial fibrillation and flutter
	Cardiac Arrest
427.5	Cardiac arrest
	Cardiac Dysrhythmia, Other
427.8x, 427.9	Other specified cardiac dysrhythmias, unspecified cardiac dysrhythmia
	Coma
780.01	Coma
	Decubiti
707.0	Decubitus ulcer
	Dementia
290.xx; 294.x; 331.xx	Senile and presenile organic psychotic conditions, other specified senile psychotic conditions, unspecified senile psychotic condition; other organic psychotic conditions (chronic); other cerebral degeneration
	Diabetes Mellitus -complicated
250.1x, 250.2x, 250.3x, 250.4x, 250.5x, 250.6x, 250.7x, 250.8x, 250.9x	Assorted complications of diabetes mellitus
	Dysphasis
787.2	Dysphasis
	Electrolyte Disorders, Misc.
275.4x; 276.9	Disorders of calcium metabolism; electrolyte imbalance, hyperchloremia, hypochloremia
	Encephalopathy
348.3	Unspecified encephalopathy
	Empyema
510.x	Empyema
	Fibrosis, Post-Inflammatory
515	Postinflammatory pulmonary fibrosis
	Gastrointestinal Hemorrhage
578.9	Unspecified hemorrhage of gastrointestinal tract

Table A.8: ICD-9-CM Codes for Risk Factors Considered, but not Included in Final Model (continued)

ICD-9-CM Code	ICD-9-CM Description
	Gastrostomy Status
V44.1; V55.1	Artificial opening status of gastrostomy; attention to artificial openings during gastrostomy
	Hemophilus Influenza
482.2	Hemophilus influenza
	Hyperosmolality
276.0	Hyperosmolality and/or hypernatremia
	Hypertension - complicated
401.0x, 401.9x, 402.00, 402.10, 402.90, 403.00, 403.10, 403.90, 404.00, 404.10, 404.90, 437.2x	Assorted complications of hypertension
	Hyperpotassemia
276.7	Hyperpotassemia
	Hyposmolality
276.1	Hyposmolality and/or hyponatremia
	Ischemic Heart Disease
410.x – 414.x	Assorted manifestations of ischemic heart disease
	Kidney Disorder, Unspecified
593.xx	Other disorders of kidney and ureter
	Mixed Acid/ Base Disorder
276.4	Mixed acid/ base disorder
	Nutritional Deficiency
260-262; 263.X-266.X; 267; 268.x-269.x; 799.4	Kwashiorkor, nutritional marasmus, other severe protein-calorie malnutrition, vitamin A deficiency, thiamine and niacin deficiency states, deficiency of B-complex components; ascorbic acid deficiency; vitamin D deficiency, other nutritional deficiencies; cachexia
	Pacemaker
V45.01	Cardiac pacemaker *in situ*
	Paroxysmal Ventricular Tachycardia
427.0, 427.1	Paroxysmal supraventricular tachycardia, paroxysmal ventricular tachycardia
	Peripheral Vascular Disease
440.xx; 441.xx; 442.xx; 443.xx	Atherosclerosis; aortic aneurysm and dissection; other aneurysm; other peripheral vascular disease
	Pleurisy
511.1, 511.8, 511.9	Pleurisy with effusion (with mention of a bacterial cause other than tuberculosis), other unspecified forms of effusion except tuberculosis, unspecified pleural effusion
	Pneumococcal pneumonia
481	Pneumococcal pneumonia
	Pregnancy
640.x-677.x	Assorted conditions associated with pregnancy
	Renal Failure
586	Unspecified renal failure
	Rheumatologic Conditions
710.x,714.xx	Diffuse disease of the connective tissue including systemic lupus erythematosus and rheumatoid arthritis
	Seizure Disorder
345.xx; 780.3x	Epilepsy, other forms of epilepsy, unspecified epilepsy; febrile convulsions, other convulsions

Table A.8: ICD-9-CM Codes for Risk Factors Considered, but not Included in Final Model (continued)

ICD-9-CM Code	ICD-9-CM Description
	Shock
785.5x; 458.0, 458.9	Shock without mention of trauma: unspecified shock, cardiogenic shock, other shock, enlargement of lymph nodes, other symptoms involving cardiovascular system; orthostatic hypotension, unspecified hypotension
	Streptococcus species
482.3x	Streptococcus unspecified, group A, group B, other
	Urinary Tract Infection
599.0	Urinary tract infection, site not specified
	Valvular Heart Disease
394.x, 395.x, 396.x, 397.x	Assorted causes of valvular heart disease
	Viral Pneumonia
480.x; 487.0	Viral Pneumonia due to adenovirus, due to respiratory syncytial virus, due to parainfluenza virus, due to other virus, unspecified; influenza with pneumonia
	Volume Depletion
276.5	Volume depletion
	White Blood Cell Dysfunction
288.x	Diseases of white blood cells

Table A.9: Prevalence (1999-2001) of Clinical Risk Factors

Risk Factor	Prevalence (Percent)
Septicemia	4.6
Respiratory failure	9.6
Staph. Pneumonia	2.8
Chronic liver disease	3.1
Lung cancer	2.5
Solid cancer, non-lung	6.5
Hematologic cancers	4.3
Chronic renal failure	5.6
Late effects of CVA	5.1
Coagulopathy	2.7
Gram negative species	2.7
CHF	27.2
Parkinson's disease	2.3
Acute CVA	1.1
Asthma	9.4
Do not resuscitate order	10.7

Do Not Resuscitate (DNR) Order

During 1999, three years after the 1996 validation study, OSHPD began collecting a clinical data field indicating the presence of a DNR order within 24 hours of a patient's admission. As was shown in Table A.9, the statewide average for the presence of a DNR order for CAP admissions between 1999 and 2001 was 10.7 percent. As can be seen in Table A.10, the percent of admissions with a DNR order varied widely among the 406 hospitals included in this report. At one extreme, thirteen (3.2 percent) of the hospitals reporting CAP admissions did not show any DNR orders, while at the other extreme 24 hospitals (5.9 percent) showed DNR rates of 25 percent or higher.

Between these two extremes, 78 hospitals (19.2 percent) fell within the modal category of "7 to 9 Percent of Admissions with DNR."

Table A.10: Distribution of "Percent of Records with DNR Order Present Within 24 Hours of Admission" for Hospitals with Ten or More Admissions

Percent of Admissions with DNR order	Number of Hospitals	Percent of Hospitals
0	13	3.2
1-3	52	12.8
4-6	61	15.0
7-9	78	19.2
10-12	57	14.0
13-15	44	10.8
16-18	35	8.6
19-21	15	3.7
22-24	13	3.2
25 or more	24	5.9
All Hospitals = 10.7% (N=406[11])		

The Accuracy of DNR

Because DNR status was not collected by OSHPD during 1996, the CAP validation study could not assess the reporting accuracy of this data element. Subsequent to 1999, the first year that DNR was included in OSHPD's Patient Discharge Data (PDD), there has not been a systematic assessment of the DNR field's reporting accuracy.

Although the validation study was not able to use a PDD-based measure of DNR, it collected a measure of "DNR order present within 24 hours of admission" directly from hospital charts and found a DNR rate of 27.0 percent. The difference between this rate and the overall rate of 10.7% for 1999-2001 PDD-based data, suggests that the hospitals in this report may have underreported the occurrences of DNR orders. At the same time, the PDD-based rate for this report is similar to a 24-hour DNR rate of 14.9 percent for CAP admissions reported by Marrie et al.[12] Further, the rates of DNR reported herein increased from 10.1 percent in 1999 to 11.2 percent in 2000 and 10.9 percent in 2001, suggesting increased reporting accuracy that is getting closer to the figure reported by Marrie et al. However, before conclusions about the reporting accuracy of the DNR indicator used in this report could be made, a separate sample survey of DNR status as recorded in hospital charts would be required.

DNR as a Risk Factor

A major finding of the 1996 validation study was that DNR status is highly predictive of 30-day mortality. DNR status exhibited an odds ratio of 17.0 that was higher than 23 of the other risk factors used in the validation study's modeling efforts. Further, its inclusion in an expanded model, along with five other clinical risk factors not available in the PDD but also taken directly

[11] Fourteen hospitals reported fewer than 10 CAP admissions, and thus could not provide reliable DNR rates. While these hospitals are included in the total for this table, they are not included in its distribution. For this reason, the Percent of Hospitals column does not add to 100.0%.

[12] See: Marrie TJ, Fine MJ, Kapoor WN, Coley CM, Singer DE, and Obrosky DS, "*Community-Acquired Pneumonia and Do Not Resuscitate Orders*", Journal of the American Geriatric Society, 2002, Feb; 50(2): 290-9. Marrie, et al reported a rate of 14.9% for a sample of 1,339 community-acquired pneumonia admissions to hospitals in the United States and Canada.

from hospital charts, substantially raised the discrimination (measured by the c-statistic) for the PDD-based risk-adjustment models from 0.80 to 0.91.

The findings of the present report are consistent with the 1996 CAP validation study in that they spotlight DNR status as a major predictor of 30-day mortality. For the 1999-2001 data, DNR's odds ratio of 4.3 (see Tables A.12 and A.13) proved to be second only to respiratory failure as the highest odds ratio in the risk-adjustment models. Also, when DNR was added to the risk-adjustment model without DNR, discrimination (measured by the c-statistic) increased from 0.79 to 0.82. It may be of further interest to note that the observed statewide death rate for CAP patients without a DNR order was 9.1 percent and for patients with a DNR order it was more than four times higher at 38.7 percent.

Construct Validity and the Use of Two Models

In this report, DNR status is intended to be an indirect indicator of illness severity at admission. Despite the predictive power of DNR status, its construct validity as an indicator of underlying illness severity has a serious limitation because it might also reflect unmeasured variation in treatment. Such variation might occur due to the reluctance of a hospital staff to provide costly treatments (apart from cardiopulmonary resuscitation) to patients with a DNR order. Furthermore, a DNR order might signal the presence of an advanced medical directive "not to treat" when the patient is terminally ill, or is in a coma with little or no hope for recovery. Under such conditions, in addition to requesting that cardiopulmonary resuscitation not be performed, the patient might request that mechanical respiration, artificial feeding, kidney dialysis, chemotherapy, or other life-saving treatments *not* be performed.

If DNR status indicates *both* underlying illness severity at the time of admission *and* variations in the treatment that might occur subsequent to admission, then its use as a risk factor creates a methodological dilemma for accurate risk-adjustment: On the one hand, risk-adjustment without DNR status could under-adjust predicted mortality because the model lacks a direct clinical indicator of illness severity. On the other hand, risk-adjustment with DNR status could over-adjust predicted mortality because the model might adjust for the type of treatment received after the admission. OSHPD's solution to this dilemma was to rate hospitals using *both* models according to the following rules:

- If the risk-adjusted mortality of a hospital was significantly *lower* than the state average using *both* models, then that hospital's mortality outcomes were rated as significantly *better* than expected.
- If the risk-adjusted mortality rates of a hospital were significantly *highe*r than the state average using *both* models, then that hospital's mortality outcomes were rated as significantly *worse* than expected.
- If a hospital's risk-adjusted mortality was rated as *expected* on *either* model, then that hospital was given an overall rating of *as expected*.

The use of both models to rate hospital performance should balance the prediction error that might result from using only one of the models.

The effect of using both models to rate hospitals is summarized in Table A.11. In this table, the marginal distributions for the separate models are very similar, with 301 hospitals rated "as expected" for both models, and between 42 and 47 hospitals rated as "better than expected" or "worse than expected" for either model. However, the ratings for 57 hospitals (14 percent of the total) changed when DNR was added as a risk factor. More specifically, the ratings of 32 hospitals improved when DNR was added to the model as a risk factor, with 17 changing from "as expected" to "better than expected," and 15 changing from "worse than expected" to "as expected." At the same time, the ratings of 24 hospitals declined, with 14 changing from "better than expected" to "as expected," and 10 changing from "as expected" to "worse than expected."

Table A.11: Balanced Hospital Ratings, With and Without DNR as a Risk Factor

		Hospital Rating With DNR As Risk Factor				
		Better (+)	**As Expected**	**Worse (−)**	**Adjusted mortality rate = 0, and N too small**	**TOTAL**
Hospital Rating Without DNR as Risk Factor	**Better (+)**	27	14	0	1	42
	As Expected	17	274	10	0	301
	Worse (−)	0	15	32	0	47
	Adjusted mortality rate = 0, and N too small	1	0	0	15	16
	TOTAL	45	303	42	16	406

The DNR rates are almost identical for the 27 hospitals rated “better than average” on both models (9.3 percent), and for the 32 hospitals rated “worse than average” on both models (9.7 percent). This suggests that our effort to balance prediction error through the use of the two models was successful.

Timing of Clinical Risk Factors

Before 1996, California hospital discharge abstracts did not include any information on the timing of diagnoses. Therefore, any acute condition could be either a comorbidity (e.g., present at admission) or a complication of care (e.g., present only after admission). After 1996, a new “condition present at admission” (CPAA) field was collected in conjunction with each recorded diagnosis. This field was used to help differentiate comorbidities from complications.

During the 6-month period before the date of their index admission, 27 percent of CAP patients had one or more prior hospitalizations. For these patients, prior discharge abstracts provided additional information about the presence and timing of clinical risk factors. If a risk factor was noted on a prior discharge abstract, then it clearly proceeded the index CAP admission included in the report and thus did not require reference to a CPAA indicator.

The Risk-Adjustment Models

Tables A.12 and A.13 show the parameters of the 1996 CAP risk-adjustment model based on 1999-2001 Patient Discharge Data.[13] In the model represented by Table A.12, that does not use DNR as a risk factor, the following risk factors were associated with a significantly **increased** risk of death within 30 days for CAP patients: increasing age (in years), male gender, septicemia, respiratory failure, staphylococcus pneumonia, chronic liver disease, lung cancer, solid cancer (non-lung), hematologic cancers, chronic renal failure, late effects of cerebrovascular accident (CVA), coagulopathy, gram negative species, congestive heart disease, Parkinson's disease, acute CVA, and number of prior discharges. Asthma was associated with a significantly **decreased** risk of death among these CAP patients. Asthma may be "protective" of mortality in this model because patients with both asthma and CAP are often treated more aggressively with a lower threshold for hospital admission.

In the model represented by Table A.13, that uses DNR as a risk factor, the same set of risk factors were associated with a significantly **increased** risk of death within 30 days for CAP patients: increasing age (in years), male gender, septicemia, respiratory failure, staphylococcus pneumonia, chronic liver disease, lung cancer, solid cancer (non-lung), hematologic cancers, chronic renal failure, late effects of CVA, coagulopathy, gram negative species, congestive heart disease, Parkinson's disease, acute CVA, and number of prior discharges. The presence of a DNR order within 24 hours of admission was also associated with an increased risk of mortality. Again, asthma was associated with a significantly **decreased** risk of death among these CAP patients.

Table A.12: Parameters for Model Without DNR as a Risk Factor

Risk Factor	Parameter Estimate	P-value	Odds Ratio	Lower 95 Percent CI For Odds Ratio	Upper 95 Percent CI For Odds Ratio
Intercept	-6.0745	<0.0001			
Age	0.0447	<0.0001	1.046	1.044	1.047
Male	0.1290	<0.0001	1.138	1.103	1.173
Septicemia	1.1032	<0.0001	3.014	2.854	3.182
Respiratory failure	1.6068	<0.0001	4.987	4.795	5.185
Staph. Pneumonia	0.6539	<0.0001	1.923	1.792	2.064
Chronic liver disease	0.6478	<0.0001	1.911	1.766	2.068
Lung cancer	1.2114	<0.0001	3.358	3.121	3.613
Solid cancer, non-lung	0.9092	<0.0001	2.482	2.363	2.608
Hematologic cancers	0.5478	<0.0001	1.729	1.625	1.840
Chronic renal failure	0.3745	<0.0001	1.454	1.373	1.541
Late effects of CVA	0.2095	<0.0001	1.233	1.162	1.308
Coagulopathy	0.7660	<0.0001	2.151	1.999	2.315
Gram negative species	0.1747	<0.0001	1.191	1.098	1.292
CHF	0.1846	<0.0001	1.203	1.164	1.243
Parkinson's disease	0.3571	<0.0001	1.429	1.316	1.553
Acute CVA	0.4271	<0.0001	1.533	1.369	1.717
Asthma	-0.7030	<0.0001	0.495	0.458	0.535
Number of prior discharges	0.1509	<0.0001	1.163	1.148	1.178

[13] All analyses in this report were conducted using SAS Statistical Software, Version 8.2, SAS Institute Inc., Cary N.C. Model parameters and odds ratios were calculated using PROC LOGISTC.

Table A.13: Parameters for Model With DNR as a Risk Factor

Risk Factor	Parameter Estimate	P-value	Odds Ratio	Lower 95 Percent CI For Odds Ratio	Upper 95 Percent CI For Odds Ratio
Intercept	-5.6876	<0.0001			
Age	0.0359	<0.0001	1.037	1.035	1.038
Male	0.1653	<0.0001	1.180	1.143	1.217
Septicemia	1.0163	<0.0001	2.763	2.614	2.921
Respiratory failure	1.6051	<0.0001	4.978	4.784	5.180
Staph. Pneumonia	0.6515	<0.0001	1.918	1.786	2.061
Chronic liver disease	0.6349	<0.0001	1.887	1.743	2.042
Lung cancer	1.0850	<0.0001	2.960	2.747	3.189
Solid cancer, non-lung	0.8455	<0.0001	2.329	2.215	2.449
Hematologic cancers	0.5591	<0.0001	1.749	1.643	1.862
Chronic renal failure	0.4149	<0.0001	1.514	1.429	1.605
Late effects of CVA	0.1296	<0.0001	1.138	1.072	1.209
Coagulopathy	0.7888	<0.0001	2.201	2.044	2.370
Gram negative species	0.1992	<0.0001	1.220	1.124	1.325
CHF	0.1845	<0.0001	1.203	1.163	1.244
Parkinson's disease	0.2635	<0.0001	1.301	1.196	1.416
Acute CVA	0.4311	<0.0001	1.539	1.371	1.727
Asthma	-0.6611	<0.0001	0.516	0.478	0.558
Number of prior discharges	0.1388	<0.0001	1.149	1.134	1.164
Do not resuscitate status	1.4587	<0.0001	4.300	4.145	4.461

Testing the Internal Validity of Risk-Adjustment Models

For this report, the internal validity of a risk-adjustment model is defined as how well it controls for differences in patient characteristics that would otherwise confound outcome comparisons across hospitals. A model that does not adequately control for such differences may generate biased and misleading estimates of risk-adjusted mortality rates. The internal validity of the risk-adjustment model was assessed in three basic ways: face validity, discrimination, and goodness of fit (i.e. calibration).

Face Validity

Members of the CAP clinical advisory panel and outside consultants carefully reviewed the CAP risk-adjustment model developed that was based on 1996 discharge data. It advised program staff about whether the model included appropriate covariates and whether the parameter estimates were consistent with previous research and experience in the field. In the judgement of this panel, the model developed by the validation study adequately represents risk factors associated with 30-day mortality for community-acquired pneumonia. The advisory panel was not reconvened for this report because the risk-adjustment procedure was recently created and validated.

Discrimination

A model with perfect discrimination would assign to every patient an expected probability of either zero or one. With perfect discrimination all persons with an expected probability of one, but no one with an expected probability of zero, would experience the outcome of interest. No model has perfect discrimination in the real world, but good models show substantial difference in the expected probability of the outcome (death) between those who actually experienced it and those who did not.

A commonly used measure of discrimination is the “c statistic,” which is based on all pairings of observations with different outcomes (i.e. all pairs involving one decedent and one survivor).[14] In this study, c can be interpreted as the degree to which any CAP patient who died within 30 days of admission had a higher “expected probability of 30-day mortality” than a surviving CAP patient. The c statistic may show a value between 0.00 and 1.00. A value higher than 0.50 indicates an overall pattern of discrimination in an expected direction, where patients who died had higher expected probabilities of death than survivors. A value of exactly 0.50 would indicate random variation, thus indicating lack of discrimination. Values less than 0.5 would indicate discrimination in an unexpected direction where patients who died had lower expected probabilities of death than survivors. There is no widely accepted cutoff for the c statistic that distinguishes "adequate" from "inadequate" risk-adjustment models. Table A.14 shows that the risk model for CAP mortality has c statistic of 0.79 (0.82 with DNR). This figure is identical to the figure reported by the 1996 CAP development and validation study, and is comparable to other models used by OSHPD in previous studies.

Table A.14: Discrimination and Goodness of Fit Tests for Re-Estimated CAP Risk-Adjusted 30-day Mortality Models

	Without DNR as a Risk Factor	With DNR as a Risk Factor
Number of Cases	203,028	203,028
Number of Deaths	24,829	24,829
30-Day Death Rate	12.23%	12.2 %
C statistic	0.79	0.82
Pearson Goodness of Fit Statistic		
Overdispersion Estimate	1.12	1.09
P-value	<0.001	<0.001

Goodness of Fit

Goodness of fit, or calibration, is the extent to which observed outcome rates correspond to predicted rates. A well-calibrated model demonstrates a strong correspondence between observed and predicted outcomes across a broad range of patient characteristics. A lack of such correspondence, or “overdispersion,” can occur for several reasons including the false assumption of a linear relationship between the logit transformation of the dependent variable (i.e. mortality) and its explanatory variables; failure to consider significant interaction terms among explanatory variables; the absence of significant explanatory variables in the model; and the presence of extreme values (i.e. outliers) in the data.

The developers of the 1996 CAP validation report found an overdispersion estimate of 1.18 that was statistically significant at $p<0.001$, thus indicating the possibility of additional interactions (i.e. in addition to “Age*Liver Disease” interaction they reported), the possibility of non-linearity, and the possibility of needing a more complete set of risk factors. However, they concluded that the absence of higher order interactions in the risk-adjustment model probably accounted for the small p value. They also concluded that the very large numbers of patients involved in the report could have resulted in the statistically significant lack of fit, even though departures from model assumptions were small. The model developers found that multiplying estimated variances by the over-dispersion estimate increased the widths of confidence intervals by only 9 percent and

[14] The “c statistic” is equivalent to the area under a receiver operating characteristic curve, which represents a plot of sensitivity versus 1-specificity at various cutoff values for the predicted probability. See: Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982; 143:29-36.

did not produce any qualitative changes in the report's findings. They concluded that there was no need for additional terms to model interactions or non-linearity.[15]

The present report obtained over-dispersion estimates of 1.12 and 1.09 that were also significant at $p < 0.001$. Since this estimate is smaller than the estimate reported in the validation study, it was also concluded that there is no need for additional terms to model interactions or non-linearity.

Exclusion from Full Risk-Adjustment

Although hospitals devote considerable effort to produce accurate discharge abstracts, the guidelines that professional coders follow when they abstract medical records are sometimes ambiguous and subject to multiple interpretations. Reimbursements are often based on diagnosis codes. Consequently, the prevalence of various CAP risk factors across hospitals can vary due to coding practices rather than differences in case-mix. In this report there was no evidence that such variability reflected unusual documentation or coding practices that would seriously distort comparisons of risk-adjusted mortality across hospitals.

However, an examination of the CPAA ("condition present at admission") indicators turned up suspected coding error for some hospitals. Generally, a secondary discharge diagnosis for a patient can be present either at the time of admission or afterwards. It is unlikely that *all* secondary diagnoses for *all* of a hospital's CAP patients would be present at admission or that *none* of them would be present at admission for *all* CAP patients, especially for hospitals with relatively large numbers of CAP patients. Among the 15 clinical risk factors used in the model, three (respiratory failure, coagulation deficit, and acute cerebrovascular accident) are regarded as 'acute', meaning they can happen either at the time of admission or afterwards. The remaining 12 clinical variables are considered "chronic" and may be regarded as present at admission. Since chronic risk factors are likely to have preceded an admission, coding errors on CPAA would be relevant primarily to the three acute clinical risk factors. Accordingly, the three acute clinical risk factors were excluded from a hospital's risk-adjustment in any of six bi-annual reporting periods for that hospital when both of the following two criteria were present:

1. There were a sufficient number of CAP discharges (i.e. 80 or more[16]) at a given hospital in a six-month reporting period to reliably assess CPAA coding.
2. Either no secondary diagnoses were reported as present at admission, or, all secondary diagnoses were reported as present at admission during the same reporting period.

Additionally, the Patient Discharge Data Section of OSHPD's Health Information Division checked the logical consistency of the data within each six-month reporting period and noted that some hospitals exhibited unacceptable CPAA indicator coding. These hospitals were excluded from full risk adjustment during a given six-month reporting period along with those meeting the two criteria listed above. Table A.15 lists those hospitals receiving partial risk adjustment for one or more of the six-month reporting periods.

[15] Haas J, et. Al., "*Report for the California Hospital Outcomes Project: Community-Acquired Pneumonia*, 1996," Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page "9-2."

[16] Haas J, et. Al., "*Report for the California Hospital Outcomes Project: Community-Acquired Pneumonia*, 1996," Sacramento, California: Health Policy and Planning Division, California Office of Statewide Health Planning and Development, November 2000: page "5-3."

Table A.15: Hospitals Excluded from Full Risk-Adjustment

Hospital Name	Six Month Reporting Period					
	1999-1	1999-2	2000-1	2000-2	2001-1	2001-2*
Alhambra Hospital-Alhambra					X	
Barstow Community Hospital		E	E	E	E	E
Bellflower Med Ctr	E					
Coast Plaza Doctors Hospital				E		
Coastal Communities Hospital					X	X
College Hospital-Costa Mesa					X	X
Columbia Mission Bay Hospital				X		
Community Hospital of Gardena					X	X
Corcoran District Hospital	X	X	X	X	X	
Daniel Freeman Marina Hospital				E		E
Eden Med Ctr						X
Emanuel Med Ctr	E	E		E		E
Encino Tarzana Rgnl Mc-Encino	E	E	E			
Fairchild Med Ctr		X	X		X	X
Good Samaritan Hospital-Bakersfield					E	
Hanford Community Hospital		X	XE			
Hollywood Community Hosp-Hollywood	E	E				
Huntington Beach Hosp & Med Ctr		E				
Lancaster Community Hospital	XE	XE	E	E	XE	XE
Lassen Community Hospital	E					
Lodi Memorial Hospital				E		
Los Angeles Co Harbor-UCLA Med Ctr				E		
Los Angeles Metropolitan Med Ctr					X	X
Madera Community Hospital				E	E	E
Mark Twain St. Joseph's Hospital		E				
Mayers Memorial Hospital						X
Memorial Hospital of Gardena					E	
Midway Hospital Med Ctr						E
Mission Community Hospital-Panorama			E	E	E	E
North Bay Med Ctr		E	E	E	E	
Ojai Valley Community Hospital	E		E			
Pacifica Hospital of the Valley	E					
Ridgecrest Community Hospital	E	E	E			
Robert F. Kennedy Med Ctr	E					
San Joaquin Community Hospital						E
San Joaquin General Hospital			E			
Santa Teresita Hospital	E		E		E	
Santa Ynez Valley Cottage Hospital					X	X
Selma District Hospital	E				E	
Sherman Oaks Hospital & Health Ctr			E			
Sierra Kings District Hospital	X	X				
South Coast Med Ctr		E	E			

*Few hospitals were excluded form full risk-adjustment during the second half of 2001. This is due, in part, to the 80 CAP patient per period criterion, which few hospitals in this table satisfied because 2001-2nd half is a low volume, 5-month period.
Key: X = inaccuracies noted by the Patient Data Section of OSHPD's Healthcare Information Division; E = possible inaccuracies detected by empirical analysis according to "criteria 1 and 2."

Table A.15: Hospitals Excluded from Full Risk-Adjustment (continued)

Hospital Name	1999-1	1999-2	2000-1	2000-2	2001-1	2001-2*
St. Francis Memorial Hospital	E	E	E	E	E	
St. Luke Med Ctr					X	X
St. Vincent Med Ctr				E		
Sutter Davis Hospital	E	E	E		E	
Sutter Merced Med Ctr	E		E			
Temple Community Hospital	E				E	
Tri-City Regional Med Ctr	E					
US Family Care Med Ctr-Montclair	E					
Vaca Valley Hospital			E	E		
Victor Valley Community Hospital	E					

*Few hospitals were excluded form full risk-adjustment during the second half of 2001. This is due, in part, to the 80 CAP patient per period criterion, which few hospitals in this table satisfied because 2001-2nd half is a low volume, 5-month period.
Key: X = inaccuracies noted by the Patient Data Section of OSHPD's Healthcare Information Division; E = possible inaccuracies detected by empirical analysis according to "criteria 1 and 2."

When partially adjusting for risk on selected hospitals, only the 12 chronic clinical risk factors and demographic variables were used, but not the three acute clinical risk factors requiring the CPAA field. Hospitals were used partially adjusted only for those six-month reporting periods where CPAA coding errors for the acute clinical risk factors were suspected.

In addition to the previously described exclusions, CHOP considered excluding hospitals (but in fact did not exclude any hospitals) from full risk-adjustment because of unusual patterns of prevalence for "key" risk factors. To assess possible coding abnormalities, the prevalences of three risk factors considered to be "key" by the development and validation study due to their association with mortality were examined. They included congestive heart disease, respiratory failure, and septicemia. Table A.16 shows the statewide prevalence and the prevalence range across hospitals, for each of the key factors. A cut-off for under- or over-coding of the key factors based on the distribution of the data was evaluated on a hospital-by-hospital basis. The hospital-specific analyses did not indicate that any hospital should be removed from the risk-adjustment process. This is consistent with the CAP validation study, which found adequate accuracy of coding on key risk factors.

Table A.16: Statewide Prevalence and Range of Key Risk Factors

Key Risk Factor	Statewide Prevalence	Range Across Hospitals
CHF	27.2 %	0 – 44.6 %
Respiratory Failure	9.6 %	1.1 – 35.0 %
Septicemia	4.6 %	0 - 16.5 %

Note: Range includes only hospitals with 30 CAP admissions and above from 1999 to 2001.

Calculation of Hospital Outcome Measures

Risk-adjusted outcomes are reported in two places: this Technical Appendix reports 30-day mortality for the three-year period using 98 percent confidence limits (see Chart 1); and a laterappendix (Appendix 3) reports each hospital's risk-adjusted death rate with 98 percent, 95 percent and 90 percent confidence limits, using aggregated 1999-2001 data and data for each separate year.

Number of Observed Deaths and Observed Death Rate

The number of observed deaths at a hospital is simply the total number of deaths within 30 days of admission, among qualifying CAP patients. The deaths may have occurred at the index hospitalization, a subsequent hospitalization, or outside a hospital setting. The observed death rate at a hospital equals the number of observed deaths, divided by the total number of qualifying patients at that hospital. This quantity was multiplied by 100 to yield a percentage.

Number of Expected Deaths and Expected Death Rate

The number of expected deaths at a hospital equals the sum of the estimated probabilities of death for all of its qualifying patients.[17] The expected death rate at a hospital equals the number of expected deaths, divided by the total number of qualifying patients at that hospital. If a hospital's expected death rate for CAP admissions is higher than the statewide death rate for CAP admissions, then patients at that hospital tend to be riskier than the statewide average. If a hospital's expected death rate is lower than the statewide death rate, then patients at that hospital tend to be healthier than the statewide average.

Risk-Adjusted Death Rate

The risk-adjusted (or indirectly standardized) death rate at a hospital equals the statewide rate, multiplied by the ratio of the number of observed deaths to the number of expected deaths at that hospital:[18]

$$I_i = s\left(\frac{\sum_{j=1}^{n_i} o_j}{\sum_{j=1}^{n_i} \hat{p}_j}\right) = s\frac{O_i}{\pi_i}$$

Where I_i is the indirectly standardized outcome rate for the ith hospital, s is the statewide outcome rate, o_j is the observed value of the adverse outcome (0 or 1) for the jth patient, and $\hat{p}_j$ is the estimated (expected) probability of the adverse outcome for the jth patient. The latter two variables are summed over all patients at the ith hospital.

The ratio of the number of observed deaths to the number of expected deaths at a hospital provides a quick assessment of that hospital's performance. For a hospital with fewer observed than expected deaths, this ratio is less than one; for a hospital with more observed than expected deaths, this ratio is greater than one. This risk-adjusted death rate provides a basis for comparing the performance of different hospitals, because each hospital's rate is adjusted to reflect what its death rate would be if its patients were about as ill as the statewide average.

Confidence Limits for Risk-Adjusted Death Rates

The size of the confidence interval indicates the reliability a hospital's risk-adjusted death rate. In general, when the upper and lower confidence limits are far apart, the estimated risk-adjusted death rate is unreliable. Assuming that the risk model is accurate, there is a 98 percent chance

that it falls within 98 percent confidence limits. Confidence limits were constructed from the standard deviation and the number of observed deaths at each hospital.[19]

[17] All analyses in this report were conducted using SAS Statistical Software, Version 8.2, SAS Institute Inc., Cary N.C. Estimated probabilities of death within 30-days of admission were calculated using PROC LOGISTC.
[18] Williams RL. Measuring the effectiveness of perinatal medical care. Medical Care 1979; 17:95-110.
[19] The methodology used to calculate these limits is described on page 93 of Chapter Eleven in the *Technical Appendix for the 1991-1993 Heart Attack Outcomes report* (www.oshpd.ca.gov).

Mortality Results

Risk-adjusted hospital outcomes based on both models are summarized in Chart 1. A row in the chart where DNR is designated as "No" indicates risk-adjusted rate of 30-day mortality using the model that does *not include DNR* as a risk factor. A row where DNR is designated as "Yes" indicates risk-adjusted 30-day mortality using the model that *includes DNR* status as a risk factor. The hospitals in Chart 1 are alphabetically listed within each county. Hospitals rated significantly better or significantly worse than expected using *both* models are highlighted with gray.

If you cannot find a particular hospital in Chart 1, it is possible that the hospital does not treat community-acquired pneumonia patients or that it is listed under another name. Separate listings of hospitals rated significantly better than average or significantly worse than average may be found in the main body of this report.

Comparing Observed and Expected Mortality

For either risk-adjustment model, two separate one-tailed analyses of statistical significance were performed to determine whether hospitals showed mortality rates that were significantly better (lower) or significantly worse (higher) than expected. Differences that, according to statistical theory, would be expected to occur by chance less than one time in a hundred were considered significant. Such differences are represented by the term "p<0.01." This is a relatively strict level of statistical significance that helps to discriminate hospitals that were "better" or "worse" than expected from those that performed "as expected" when compared to the state average.

The exact probability of the number of observed deaths (or a more extreme number) occurring by chance, given the number of expected deaths at a hospital, was used to identify outlier hospitals. This approach differs from the more widely used normal approximation in that it relies on fewer distributional assumptions and gives better estimates for hospitals with relatively few expected deaths.[20]

If the number of observed deaths exceeded the number of expected deaths, an upper probability (p) value was computed. If the number of observed deaths was less than or equal to the number of expected deaths, a lower probability (p) value was computed. The classification of a hospital's CAP death rate as "significantly better than expected," "significantly worse than expected," or "not significantly different than expected" was based on a p-value threshold of 0.01. Hospitals classified as significantly better than expected had fewer deaths than expected and a p-value less than 0.01. Hospitals classified as significantly worse than expected had more deaths than expected and a p-value less than 0.01. This is equivalent to a two-tailed significance test based on a 98 percent confidence interval.

Hospitals showing mortality rates significantly better than expected (p<0.01) are represented by a plus sign (+). Hospitals showing mortality rates significantly worse than expected (p<0.01) are represented by a minus sign (–). Hospitals that were not significantly different than expected (i.e. that were in a middle range because they were neither significantly better nor significantly worse) are not assigned a symbol. An asterisk (＊) represents hospitals that had no CAP-related deaths between 1998-2000, but treated too few community-acquired pneumonia cases to be classified as significantly better than expected.

[20] Luft HS, Brown BW Jr. Calculating the probability of rare events: Why settle for an approximation? Health Services Research 1993; 28:419-439.

Symbols representing results:

(+) Significantly better than expected ($p<0.01$)
(–) Significantly worse than expected ($p<0.01$)
(0) No deaths reported, and too few cases to determine statistical significance

Absence of a symbol indicates performance "as expected"

Comparing Risk-Adjusted Hospital Rates with the Statewide Death Rate

Chart 1 compares the risk-adjusted death rates of hospitals to the statewide rate using both models. The black solid circle (●) on a row's horizontal bar marks the hospital's risk-adjusted mortality rate. The number on the bar is a hospital's risk-adjusted 30-day mortality rate. A vertical hyphenated line extending from the top to the bottom of the chart represents the overall, statewide 30-day mortality rate for CAP admissions.

Two separate one-tailed, 1 percent significance tests were combined to produce the 98 percent confidence intervals around a risk-adjusted rate. The bars represent the 98 percent confidence bounds surrounding an adjusted mortality rate. If each hospital's population of CAP patients in this report is viewed as a separate random sample from the state's population of hospital admissions, then the interval may be interpreted to mean that there is a 98 percent probability that any given hospital's true risk-adjusted mortality rate falls somewhere along that bar. Therefore, if the bar crosses the state average, the hospital's 30-day mortality rate is considered "not significantly different" from the state average. If the bar does not cross the state average, then the difference between the hospital's 30-day mortality rate and the state's rate is considered "statistically significant." In a few instances, the bar representing a hospital's confidence interval was too wide to completely fit onto Chart 1. When this happened, a portion of the interval on one side of a mortality rate (●) was truncated, as represented by an arrow (← or →) at the end of the bar. In general, the more cases a hospital admits, the smaller the confidence interval surrounding its risk-adjusted rate. This is because, according to statistical theory, larger samples yield more reliable results.

Table A.17 shows the number of patients and the number of deaths at hospitals that admitted 30 or fewer patients during the three-year period of this report. These small numbers often resulted in extremely wide confidence intervals that cannot be meaningfully interpreted. Thus, these hospitals were not graphically displayed in Chart 1. None of the hospitals in this table were rated as significantly higher or significantly lower than the statewide 30-day mortality rate. It should be noted that patient data from all of these hospitals were used to create the general, statewide risk-adjustment models of this 1999-2001 report.

Table A.17: Number of Observed Deaths Within 30-Days of Admission for Hospitals with Less than 30 Adult Admissions for Community-Acquired Pneumonia, 1999-2001

County	Hospital	Number of Patients Admitted	Number of Deaths
Alameda	Children's Hospital Med Center of No Cal (o)	4	0
Inyo	Southern Inyo Hospital	23	3
Los Angeles	Avalon Municipal Hospital & Clinic	8	1
Los Angeles	Barlow Hospital	15	2
Los Angeles	Children's Hospital of Los Angeles	24	1
Los Angeles	Orthopaedic Hospital (o)	10	0
Los Angeles	Doctors Hospital of West Covina	15	2
Los Angeles	Los Angeles County Rancho Los Amigos MC (o)	9	0
Los Angeles	Earl & Loraine Miller Children's Hosp (o)	4	0
Madera	Chowchilla District Memorial Hosp (o)	3	0
Madera	Valley Children's Hospital *	22	3
Marin	Novato Community Hospital-Rowland	26	3
Merced	Dos Palos Memorial Hospital *	18	1
Modoc	Surprise Valley Community Hospital	17	3
Mono	Mammoth Hospital (o)	28	0
Napa	Nelson M Holderman Memorial Hosp	30	1
Orange	Children's Hospital of Orange County (o)	6	0
Orange	Vencor Hospital-Brea (o)	1	0
Riverside	The Heart Hospital, Inc. (o)	3	0
San Bernardino	Vencor Hospital-Ontario (o)	1	0
San Bernardino	Heritage Hospital (o)	1	0
San Diego	Children's Hospital-San Diego (o)	21	0
San Diego	Sharp Cabrillo Hospital (o)	9	0
San Diego	Vencor Hospital-San Diego	3	1
San Mateo	Seton Med Ctr-Coastside	1	1
Santa Clara	Lucile S Packard Children’s Hosp at Stanford (o)	2	0
Sierra	Sierra Valley District Hospital	8	1

(o) = No deaths and too few cases to determine statistical significance.
* = Hospital comments letter received. See Appendix 2.